



Readers may recall that around two years ago, we published an article on Yaesu's System Fusion along with reviews of several of the radios available at the time, which were capable of running C4FM, the digital component of System Fusion.

When our editor was talking recently with Karl Brazier of Yaesu UK, Karl suggested that it might be time for an update on Fusion because things have moved on from the initial implementation of System Fusion with some exciting new features and capabilities as well as a new range of lower cost radios capable of C4FM.

Basics

Perhaps the main underpinning principle of System Fusion is still that it encompasses both digital and analogue communication. It is perfectly possible for someone with an FM handheld to access a node and communicate with someone using a digital radio. All the Fusion-capable radios have a feature called Automatic Mode Select (AMS), which means that if the radio hears a digital C4FM transmission, it will respond in C4FM mode, but if it hears analogue FM, it will respond in FM.

It's probably worth saying that the C4FM digital mode is not compatible with either DMR or D-STAR radios, although many digital radio enthusiasts, myself included, have radios for each of these modes.

In the last year or so, Yaesu have launched 'System Fusion II', which adds two new main features – Digital Group ID (DGID) and Digital Personal ID (DPID) – that I will go on to explain shortly. In addition, of interest to repeater owners, there is the introduction of Internet Linked Multi Repeater System (IMRS), which we will also cover.

Operating Modes & Facilities

There are four operating modes of System Fusion, three digital and one analogue. The digital modes comprise a Narrow Voice mode (DN), which carries voice along with data such as callsign/name and GPS co-ordinates; a Wide Voice mode (VW), which carries the highest quality voice transmission; and a data mode, which can be used for sending text or low-resolution pictures. All the digital transmission modes are confined

Revisiting Yaesu's System Fusion

In the first of a short series of articles, Tim Kirby G4VXE brings readers up-to-date with developments in Yaesu's System Fusion.



Fig. 1: C4FM modulation is used in three different ways in System Fusion, all in 12.5kHz FDMA.

to a 12.5kHz bandwidth and **Fig. 1** illustrates how each mode apportions the bandwidth. Finally, of course, there is analogue FM. Each of the Yaesu System Fusion radios supports all these modes.

For the FT-1XDE, FT-2DE, FTM-100DE and FTM-400DE models there is a camera microphone available. The images are VGA quality so definitely not high resolution but it's quite fun to be able to send pictures and there might be some practical applications for this, for example in emergency communications. In order to send text and pictures, you will need to install a micro-SD card in your transceiver.

Fusion-Enabled Repeaters

Yaesu also supply System Fusion capable repeaters, the first of which was the DR-1XE. This has now been replaced by the DR-2XE, which we will cover in a separate article. Both the DR-1XE and the DR-2XE support these four modes and will also switch automatically between the modes if they are so configured. It is also possible to configure the repeaters to stay in digital or, indeed, analogue mode and a number of repeater groups have done just this so that only digital, or only analogue, can be used on the repeater.

Fusion and Digital Radio Hotspots

It's probably also worth saying that if you have one of the MMDVM-based hotspots, then if you also have a Fusion radio, you

can use the hotspot to come out on all modes, DMR, NXDN, P25 – everything in fact, apart from D-STAR. Although the Fusion radios work very well with hotspots, Karl Brazier was at pains to point out that unless you are using a Fusion enabled repeater or node, you would not be able to take advantage of all the advanced features that System Fusion offers.

What's New in System Fusion II?

The first new feature is Digital Group ID (DGID). This is important because it allows different radios to be set up with different DGIDs (there's a range of values from 00 to 99). Radios set with the same DGIDs can hear each other, but radios with a different DGID, even if on the same frequency, will not hear the voice traffic, although the S-meter will indicate a signal. DGID is illustrated in **Fig. 2**.

The second new feature is Digital Personal ID (DPID), which is used to identify a particular transceiver/operator. You might use this, for example, to enable only particular people to access the control channel of a repeater. Up to 24 stations can be registered in this way. Or perhaps, in an emergency communication scenario, you might use DPID to restrict your communication to particular radios (note that this is restriction and not encryption).

All Yaesu Fusion radios can support the new System Fusion II features, DGID and DPID. You may, however, need to do

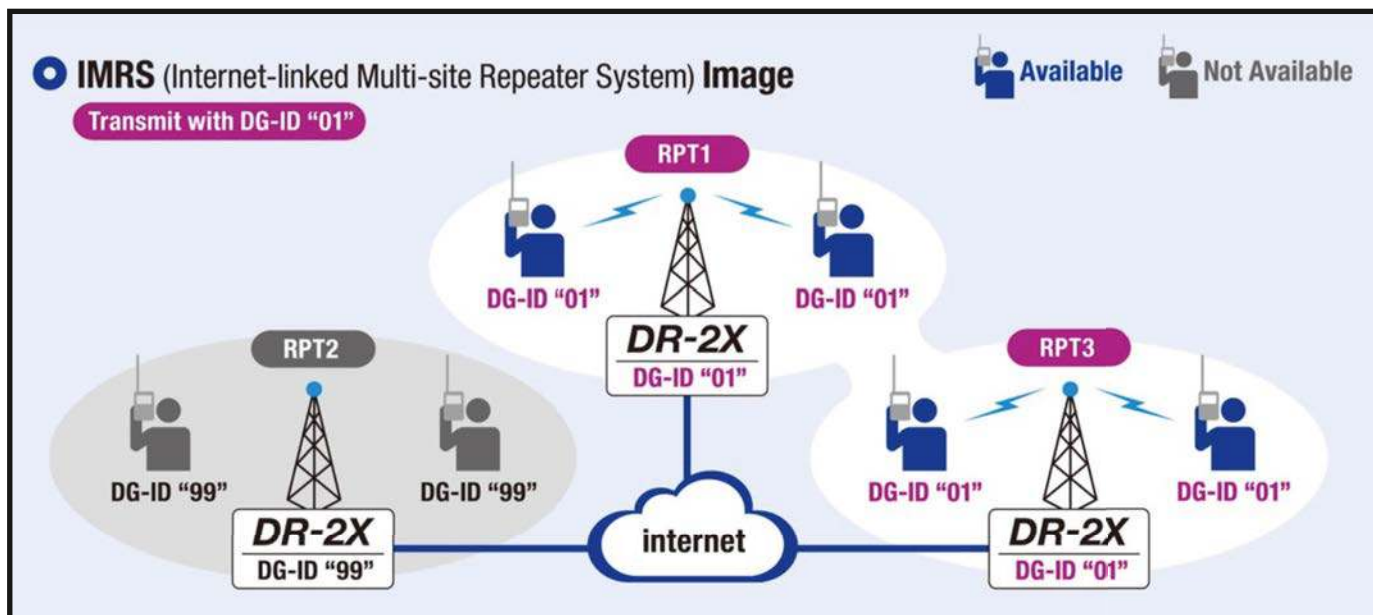


Fig. 2: An example of the use of Digital Group ID (DGID) when linking repeaters together. Users on Repeaters 1 and 3, using DGID 01, will all hear each other and be able to converse. Users on Repeater 2, using DGID 99, will not hear the conversations from Repeaters 1 and 3. Of course, there is nothing to stop the repeater keeper of Repeater 2 switching it on to DGID, allowing traffic from Repeaters 1 and 3 to be heard as well!

a firmware upgrade, particularly if you bought an FT-1, FT-2, FTM-100DE, FTM-400DE/XDE or the FT-991A. The newer radios, such as the FT-70DE, FTM-3200DE, FTM-3207DE and the FTM-7250DE all have DGID and DPID capability included.

Firmware upgrades are available, if needed, from the **Yaesu.com** website. Simply look up the rig you are interested in and navigate to that page on the website. You will find a tab on the page entitled 'Files' and there, under Amateur Radio \Software you will see a Firmware Update that you can download along with instructions on how to do this as well as a description of the changes that this firmware provides.

Don't forget, if you have an FT-991A, which perhaps you bought mostly for HF or 50MHz, you already have Fusion capability. Some people have been trying C4FM on the 28/29MHz band, which should be quite interesting.

Yaesu claim that C4FM modulation has better Bit Error Rate (BER) characteristics when compared to other digital modulation systems and 'guarantees reliable communication' – a brave claim indeed! My own experiments show that even at minimal signal levels, C4FM works very

reliably and does give very clear audio. C4FM also appears to recover quickly from dropouts or signal interruptions.

GPS Functionality

The FT-1XDE, FT-2DE, FTM-100DE and FTM-400(X)DE models all include GPS functionality, which can be used for APRS, both terrestrially and through satellites. They also include Back Track and Smart Navigation features. Backtrack allows you to store a GPS location and then track back to it, using the radio's built-in compass. The Smart Navigation feature allows you to navigate to another station's GPS Coordinates using the on-screen compass.

WIRES-X

If you have an internet-connected Fusion repeater close to you, then you can use the Wide-coverage Internet Repeater Enhancement System or WIRES-X. Using your Fusion-enabled radio, you can connect to other WIRES-X enabled nodes, which may be gateways or link stations to repeaters or to WIRES-X rooms that are the Fusion equivalent of a DMR talkgroup, DMR reflector or, if that doesn't help, think of it as a conference call! Many other stations can connect to the room, either directly or via repeaters and gateways.

A very popular WIRES-X room in the UK is 'CQ-UK', which can be accessed directly using your own WIRES-X node, a repeater or through digital radio hotspots. The people behind the CQ-UK room have worked particularly hard to achieve interoperability and you can connect to it from all the various digital voice modes:

D-STAR, DMR, NXDN and P25 as well as Zello for Network Radio/smartphone users.

Looking further afield, the AMERICA-LINK room is also very popular and is often well worth listening to, particularly in the afternoons and evenings, UK time.

Most Fusion enabled repeaters have their own WIRES-X room, so that users out of direct RF range can still connect and speak to users of that repeater.

The FT-1XDE, FT-2DE, FTM-100DE and FTM-400(X)DE series rigs all have WIRES-X buttons, which you can press when you are in range of a WIRES-X enabled repeater, allowing you to search for rooms to connect to. The newer, lower cost units such as the FT-70DE, FTM-3200DE, FTM-3207DE and FTM-7250DE do not have a WIRES-X button but do allow you to connect to the WIRES-X system. You will need to know the number of the WIRES-X node or room, which you can obtain from the internet at:

<https://tinyurl.com/ydfdoc3b>

If you use the node or room regularly, you can store the number in a memory on the rig or just enter it from the microphone keypad, press # and you will be connected. When you want to disconnect, you press the * key.

If you don't have a WIRES-X enabled repeater close to you, you can create your own WIRES-X node, using an HRI-200 box and a node radio. This will need to be an FTM-100DE or FTM-400(X)DE. You can run the node in either digital or analogue mode. If you run it in digital mode, then you will need a Fusion-enabled handheld or other rig to access your node with. If

you run it in digital mode, then you can use any analogue radio to access the node, which is what a lot of people do initially before graduating to an all-digital system. Incidentally, if you are creating an analogue-based WIRES-X node, there is a cable included with the HRI-200 box that will fit any radio with a suitable packet port, such as from Yaesu, Icom or Kenwood – it doesn't have to be one of the Yaesu models.

Internet Linked Multi Repeater System (IMRS)

With the new DR-2XE repeaters it is possible to add a local area network (ethernet) card into the repeaters. This makes it possible to link one or more repeaters across a TCP/IP link – that could be a few feet to the other side of the world! Your instinct may be to use the internet to connect the repeaters but depending on your application, you could use WiFi, a private or other network. For emergency communications, you will probably not want to rely on an internet circuit although you can provide all sorts of failover capability as required.

Using IMRS, you can connect repeaters together, perhaps in neighbouring cities or towns. Using the Digital Group ID features, you can choose which traffic is passed from one repeater to another. Of course, it makes no difference which band (2m or 70cm) the repeater is on, so you might well access repeater A on 70cm and come out on repeater B that is on 2m. Karl Brazier and I had great fun making this work in the lab at Yaesu UK in Winchester. It works very well.

Once there is a critical mass of DR-2XE repeaters with internet connectivity, it would be easy to connect links over wide areas – perhaps there is an opportunity for some like-minded individuals to co-operate on such a project.

Forthcoming Articles about System Fusion

We will do a brief review of the DR-2XE



Fig. 3: Two Fusion-capable rigs from Yaesu, the FTM-7250DE and the FTM-100DE

repeater in a forthcoming issue of *PW* but if you or your repeater group are an owner of one of the older DR-1XE repeaters and you are interested in upgrading to the newer model, please contact Karl Brazier at Yaesu UK because there are some deals that expire at the end of 2018. Karl will give you more information.

Is System Fusion for you?

The answer to whether System Fusion is for you may well depend on where you live and where your interest in digital communications lies. If you are in an area of the country served by a Fusion repeater or node, then it's very likely that you will enjoy using Fusion-enabled radios. However, if there are no repeaters or nodes available, then it's possible that you will not use the digital side of the radio at all, which would be a shame.

If you are sufficiently interested in digital communications to have either a hotspot or a Fusion node yourself, then again, you will almost certainly enjoy having a Fusion radio available.

And if you have a MMDVM-based hotspot, then you can dip a toe in the

Fusion water without a Fusion radio, by cross-moding to the YSF networks from DMR. Do note, though, that this will not give you direct access to any WIRES-X rooms or nodes or many of the advanced features. It does, however, enable you to sample activity on some of the major WIRES-X rooms such as AMERICA-LINK and CQ-UK.

You can refer to previous editions of *PW* for reviews of the FT-2DE, FT-70DE, FTM-100DE and FTM-400(X)DE models and next month, with the Editor's permission, we will review the FTM-7250DE 2m/70cm dual-band C4FM/FM mobile, **Fig. 3**. The article will also cover the single-band mobile rigs, the FTM-3200DE for 2m and FTM-3207DE for 70cm. It is fair to say that all the models perform well, with the quality that you would expect from one of the major amateur radio manufacturers.

Thank You

Many thanks to Karl Brazier of Yaesu UK for his help in preparing this article as well as an excellent demonstration of System Fusion's capabilities.

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